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FLOOD INSURANCE STUDY

COMPLETED
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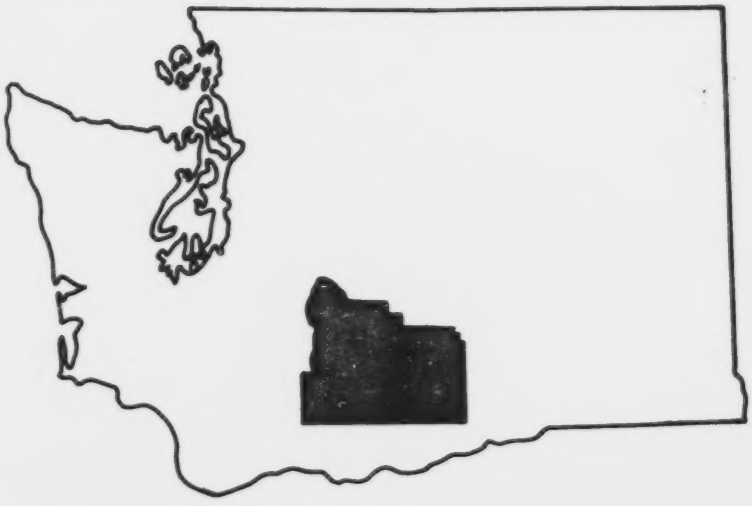
CITY OF SELAH, WASHINGTON
YAKIMA COUNTY



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Yakima River — Panel 01P

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PUBLISHED SEPARATELY:

Flood Insurance Rate Map

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FLOOD INSURANCE STUDY
CITY OF SELAH, WASHINGTON

1.0 INTRODUCTION

1.1 Purpose of Study

The purpose of this Flood Insurance Study is to investigate the existence and severity of flood hazards in the City of Selah, Yakima County, Washington, and to aid in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Initial use of this information will be to convert the City of Selah to the regular program of flood insurance by the Federal Emergency Management Agency (FEMA). Further use of the information will be made by local and regional planners in their efforts to promote sound land use and flood plain development.

1.2 Coordination

The identification of streams selected for detailed analysis was determined at the initial Consultation and Coordination Officer's (CCO) meeting attended by representatives of the community, the study contractor, and the FEMA, on April 12, 1976.

During the course of the work, numerous informal contacts were made by the study contractor with the community for the purpose of obtaining data. Previous work by the U. S. Army Corps of Engineers (COE) was reviewed and forms the basis of this study.

On March 24, 1977, the preliminary results of the work were reviewed at an intermediate CCO meeting attended by representatives of the city, Yakima County, the study contractor, and the FEMA.

A final CCO meeting held on October 14, 1980, resulted in agreement on the report by all parties. This report incorporated resolutions of all comments received as a result of coordination activities.

1.3 Authority and Acknowledgements

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968, as amended.

The hydrologic and hydraulic analyses for this study were performed by Tudor Engineering Company for the Federal Emergency Management

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under Contract No. H-4021. This work, which was completed in August 1977, covered all significant flooding sources in the City of Selah.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the City of Selah, Yakima County, Washington. The area of study is shown on the Vicinity Map (Figure 1).

Flooding in the City of Selah is caused by overflow of the Yakima River, which flows in a southerly direction to the east of the city before passing through the Selah Gap.

Only that portion of the river that extends from the South First Street bridge to a point two miles upstream from the bridge was studied in detail. The area subject to flooding includes unincorporated areas northeast of the city, at present only partially developed.

This area studied by detailed methods was selected with priority given to all known flood hazard areas, areas of projected development, and proposed construction for the next five years, through August 1982.

2.2 Community Description

The City of Selah is located in the Yakima Valley, just upstream of the Yakima River's confluence with the Naches River, and approximately 4 miles north of the City of Yakima, the county seat of Yakima County. Settlement by non-Indians in the Yakima Valley dates from the 1850s. Development of Selah began following a Bureau of Reclamation irrigation project in 1908. By 1940, the population of Selah was 1,130 persons, and growth continued steadily, to a 1975 population of 3,637 residents (References 1 and 2).

Selah is located on the western edge of the Selah Valley, approximately 1-1/2 miles wide. The Yakima River flows south through the valley, and thence through the short canyon known as Selah Gap immediately upstream of the mouth of the Naches River.

Much of the valley in the proximity of the main Yakima River channel shows the braided pattern of a number of old river channels.

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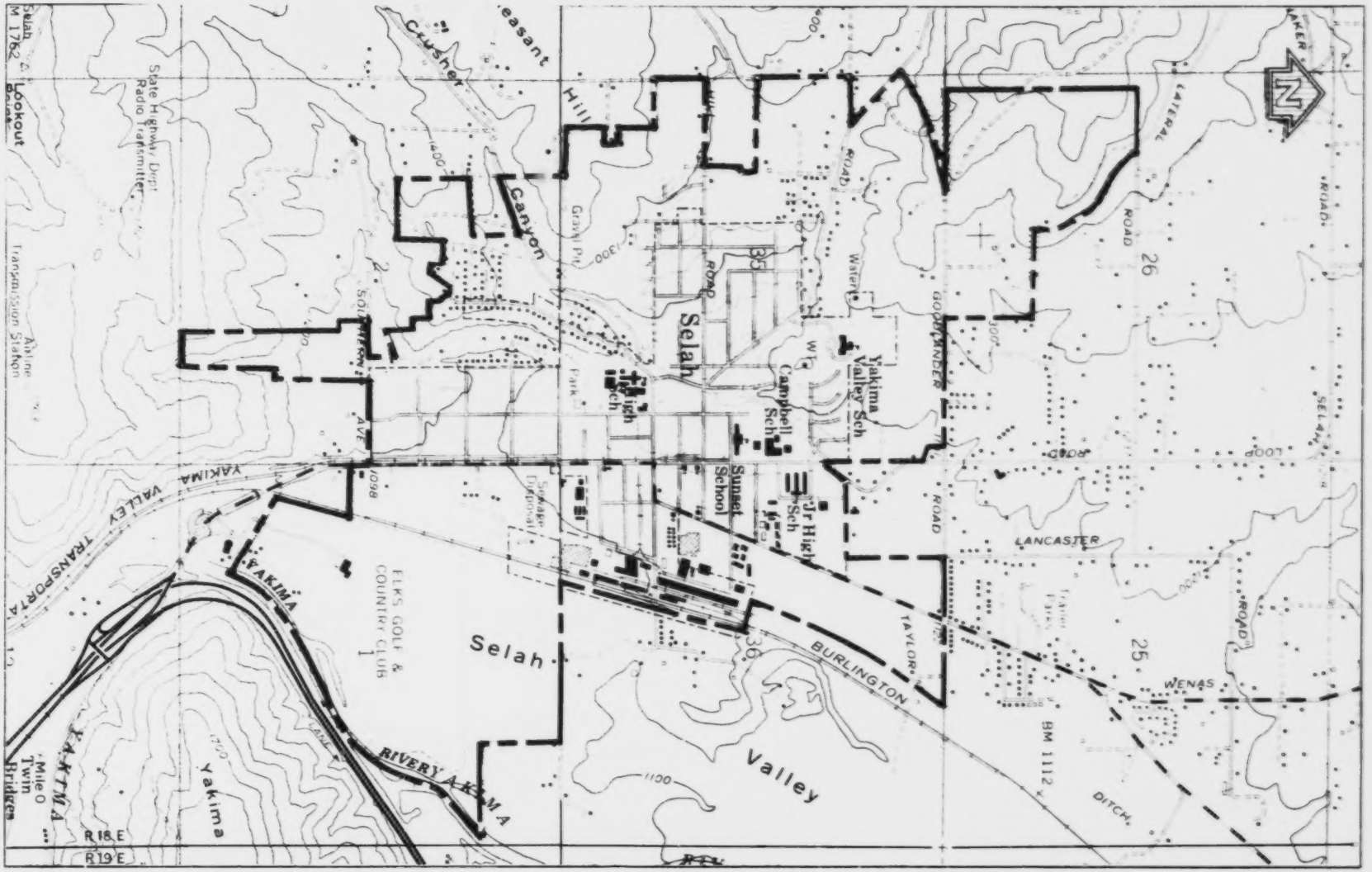

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SELAH, WA
(YAKIMA CO.)

APPROXIMATE SCALE
2000 0 2000 4000 6000 FEET

VICINITY MAP

These areas are generally gravelly, and frequently covered by dense brush or woods. Extensive excavation for gravel occurs in this area especially on the left bank, and some of the borrow pits have been developed into recreational lakes. A large cattle feeding operation occupies much of the right bank flood plain. The remainder of the valley is primarily devoted to irrigated pasture, but includes some residential development and a private golf course and country club. The valley is traversed and crossed by several minor highways, a main Burlington Northern Railroad line, U. S. Highway 97, and Interstate 82. An extensive fruit processing storage complex, with associated railway trackage, occupies a large area on the right bank within the city limits of Selah. The valley is also traversed by several irrigation canals and an extensive system of drains.

The summertime climate of the Yakima River Basin is hot and dry, typical of the continental type. Winters are moderately cold and cloudy, with more than 75 percent of the annual precipitation occurring in the period of October through March. Annual precipitation decreases from more than 100 inches in the Cascade Mountains to less than 10 inches in the lower elevations near the mouth of the Yakima River. Snowfall in excess of 400 inches falls on the higher slopes of the Cascade Mountains with the lower valleys receiving 15 to 20 inches (Reference 3).

Wintertime temperatures normally range from near 20°F at night to near 30°F in the daytime, but temperatures of 0°F or below can be expected about every other year on the average in January or February. Normal summertime temperatures reach 90°F during the daytime but cool rapidly to near 60°F at night. Temperatures exceeding 100°F are not uncommon and a few readings over 110°F have been recorded.

The Yakima River has a drainage area of approximately 6,155 square miles at its mouth and is a principal tributary of the Columbia River. The headwaters originate in the Cascade Mountain Range at a peak elevation of about 8,000 feet. From Snoqualmie Pass (elevation 3,010 feet), the river passes through Keechelus Lake, and then flows southeasterly for about 200 miles to join the Columbia River at Richland, Washington (elevation 340 feet). The average slope of the streambed through the study reach is approximately 10 feet per mile.

2.3 Principal Flood Problems

The Yakima River Basin is subject to floods of two types, namely, the more severe but less frequent winter flood resulting largely

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from rainfall, and the less severe spring flood caused primarily by snowmelt. The river is partially regulated by irrigation reservoirs in the headwaters, which provide some degree of flood protection as described in Section 2.4 (Reference 4).

The Yakima River begins to overtop its banks when the flow, measured 20 miles upstream of Selah at the Umatanum, Washington gage, exceeds approximately 10,000 cubic feet per second (cfs). There have been 23 such occurrences since establishment of the gage in 1906, of which about half have been spring floods. The three highest discharges, which may be termed major floods, were:

Date of Crest	Estimated Peak Discharge
November 15, 1906	41,000 cfs
December 23, 1933	32,200 cfs
May 29, 1948	27,800 cfs

The 1906 flood occurred prior to construction of upstream reservoirs. The 1933 and 1948 peak discharges were materially reduced by the operation of the upstream reservoirs.

The 1948 flood resulted in about 10 families being driven from their homes, considerable damage to buildings and crop land, and one fatality due to a flood-induced heart attack (Reference 5).

2.4 Flood Protection Measures

Three Bureau of Reclamation irrigation reservoirs having a combined storage capacity of 833,000 acre-feet are operated upstream from the study reach. The reservoirs are described in Table 1, "Reservoir Data."

TABLE 1 - RESERVOIR DATA

Name	Stream	Distance Above Selah (Miles)	Storage Capacity (Acre Feet)	Completion Date
Keechelus	Yakima (above Cle Elum)	113	157,180	1917
Kachess Dam	Kachess	105	239,000	1912
Cle Elum Dam	Cle Elum	100	436,900	1933

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The reservoirs substantially reduce flood flows when floods are coincident with a low water-surface elevation in the reservoirs. However, reservoir regulation is not presently used as a flood control operating requirement, and is only provided on a voluntary basis to the extent that irrigation storage requirements are not jeopardized.

The Yakima River is in State Flood Control Zone No. 9 under Chapter 86.16 of the Revised Code of Washington. The city and county governments are obligated to abide by the provisions of a 1973 amendment, and may be authorized to administer the statute. Under the statute, permits must be obtained for proposed developments within the flood plain. Such permits stipulate a permissible floor elevation and are not issued if the proposed development is located within a floodway. The stipulated recurrence interval is for the 100-year flood.

3.0 ENGINEERING METHODS

For the flooding source studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Floods having recurrence intervals of 10, 50, 100, and 500 years have been selected as having special significance for flood plain management and for flood insurance premium rates. The analyses reported here reflect current conditions in the watershed of the flooding source.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for floods of selected recurrence intervals for the stream studied in detail in the City of Selah.

Flood flow frequency data was based on a statistical analysis of discharge records at gaging stations located near Parker, Washington, and at Umtanum, Washington, operated since 1908 and 1906, respectively. Analyses were performed by the COE, but not published, in accordance with the standard log-Pearson Type III methods as outlined by the Water Resources Council (Reference 6). The resulting frequency curves were made available, and were verified by independent analysis conducted by the study contractor. The discharges are shown in Table 2, "Summary of Discharges."

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TABLE 2 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
YAKIMA RIVER					
At Selah Corporate Limits	2,112	15,900	26,700	35,300	58,900

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of the Yakima River in the vicinity of Selah were carried out to provide estimates of water-surface elevations for flood flows of the selected recurrence intervals.

The COE had previously developed the physical data and determined the loss coefficients which were used to derive a step-backwater computer model for the Yakima River (References 4 and 7). The physical data, including cross sections and reach lengths, were verified using existing topographic maps having a contour interval of 2 feet (Reference 8). Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway is computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2). The roughness coefficient values for the channel determined by the COE varied between 0.025 to 0.035; roughness coefficients for the overbanks varied between 0.035 to 0.150.

Flood profiles for the 50- and 100-year floods and the 100-year floodway were previously determined by the COE. Flood profiles for the 10- and 500-year events were developed by the study contractor by substituting the respective discharges into the COE's step-backwater model. Starting water-surface elevations for these latter floods were determined by developing an elevation-discharge curve using elevations and discharges previously reported by the COE for the 25-, 50-, 100-, 200-year and Standard Project Floods (Reference 4). The final flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals.

Elevation reference marks used in this study are shown on the maps. All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD), formerly referred to as Sea Level Datum of 1929.

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The hydraulic analyses for this study are based only on the effects of unobstructed flow. The flood elevations as shown on the profiles are thus considered valid only if hydraulic structures in general remain unobstructed and do not fail.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

A prime purpose of the National Flood Insurance Program is to encourage state and local governments to adopt sound flood plain management programs. Each Flood Insurance Study, therefore, includes a flood boundary map designed to assist communities in developing sound flood plain management measures.

4.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by the FEMA as the base flood for purposes of flood plain management measures. The 500-year flood is employed to indicate additional areas of flood risk in the community. For the stream studied in detail, the boundaries of the 100-year and the 500-year flood have been delineated using the flood elevations determined at each cross section; between cross sections, the boundaries were interpolated using topographic maps at a scale of 1"=200' with a contour interval of 2 feet, supplemented by spot elevations at approximately 250-foot spacing (Reference 8). In cases where the 100- and 500-year flood boundaries are close together, only the 100-year boundary has been shown.

The boundaries of the 100- and 500-year floods are shown on the Flood Boundary and Floodway Map (Exhibit 2). Small areas within the flood boundaries may lie above the flood elevations and, therefore, may not be subject to flooding. Owing to limitations of the map scale, such areas are not shown.

4.2 Floodways

Encroachment on flood plains, such as artificial fill, reduces the flood-carrying capacity, increases the flood heights of streams, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the Flood Insurance Program, the concept of a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area

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of the 100-year flood is divided into a floodway and a floodway fringe. The floodway is the channel of a stream plus any adjacent flood plain areas that must be kept free of encroachment in order that the 100-year flood may be carried without substantial increases in flood heights. Minimum standards of the FEMA limit such increases in flood heights to 1.0 foot, provided that hazardous velocities are not produced. The floodway in this report is presented to local agencies as a minimum standard that can be adopted or that can be used as a basis for additional studies.

The floodway presented in this study was computed on the basis of equal conveyance reduction from each side of the flood plain. The results of these computations are tabulated at selected cross sections for each stream segment for which a floodway is computed (Table 3).

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway widths were determined at cross sections; between cross sections, the boundaries were interpolated. However, only those widths located within the corporate limits are shown. In cases where the boundaries of the floodway and the 100-year flood are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and the boundary of the 100-year flood is termed the floodway fringe. The floodway fringe thus encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 2.

5.0 INSURANCE APPLICATION

In order to establish actuarial insurance rates, the FEMA has developed a process to transform the data from the engineering study into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors (FHFs), and flood insurance zone designations for each flooding source affecting the City of Selah.

5.1 Reach Determinations

Reaches are defined as lengths of watercourses having relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH[2] (FT.)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	WITH FLOODWAY (NGVD)	WITHOUT FLOODWAY (NGVD)	DIFFERENCE (FT.)
Yakima River							
A	117.31	676/575	6,333	5.6	1089.3	1088.6	0.7
B	117.49	955/845	7,627	4.6	1090.2	1089.5	0.7
C	117.78	1042/905	7,539	4.7	1091.5	1090.8	0.7
D	117.92	845/520	6,477	5.4	1092.2	1091.7	0.5
E	118.22	989/0	4,972	7.1	1094.9	1094.4	0.5
F	118.36	1548/0	8,911	4.0	1096.7	1096.3	0.4
G	118.55	1573/0	7,577	4.7	1098.3	1097.8	0.5

[1]Miles above mouth

[2]Width/width within corporate limits

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SELAH, WA
(YAKIMA CO.)

FLOODWAY DATA

YAKIMA RIVER

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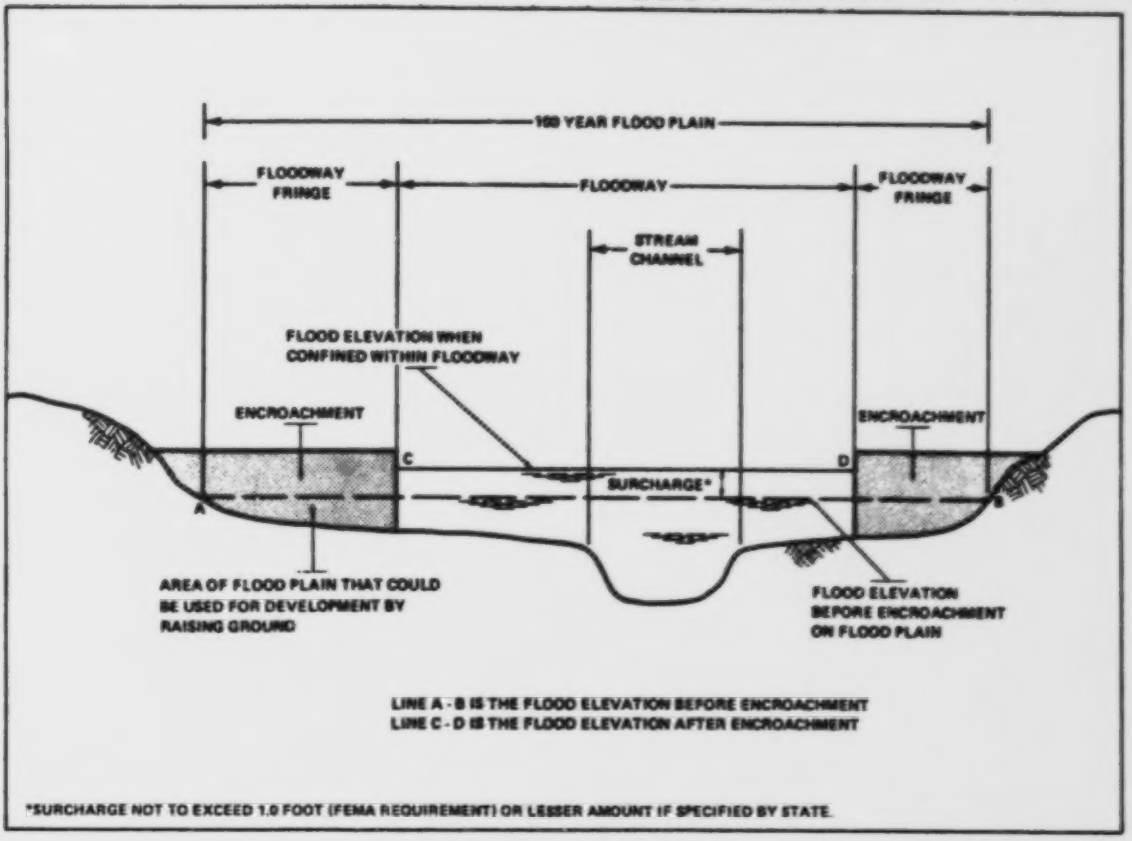
100 YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE A - B IS THE FLOOD ELEVATION BEFORE ENCROACHMENT
LINE C - D IS THE FLOOD ELEVATION AFTER ENCROACHMENT
*SURCHARGE NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE.

FLOODWAY SCHEMATIC Figure 2

difference does not have a variation greater than that indicated in the following table for more than 20 percent of the reach.

Average Difference Between 10- and 100-Year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

One reach on the Yakima River meeting the above criterion was required for the flooding source of the City of Selah. The location of that reach is shown on the Flood Profiles (Exhibit 1).

5.2 Flood Hazard Factors

The FHF is the FEMA device used to correlate flood information with insurance rate tables. Correlations between property damages from

floods and their FHFs are used to set actuarial insurance premium rate tables based on FHFs from 005 to 200.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations expressed to the nearest one-half foot, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and the 100-year water-surface elevations is greater than 10.0 feet, accuracy for the FHF is to the nearest foot.

5.3 Flood Insurance Zones

After the determination of reaches and their respective FHFs, the entire incorporated area of Selah was divided into zones, each having a specific flood potential or hazard. Each zone was assigned one of the following flood insurance zone designations:

Zone A8:	Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations shown, and zones assigned according to FHFs.
Zone B:	Areas between the Special Flood Hazard Areas and the limits of the 500-year flood plain that are protected from the 100-year flood by dike, levee or other water control structure, also areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.
Zone C:	Areas of minimal flooding.

Table 4, "Flood Insurance Zone Data," summarizes the flood elevation differences, FHFs, flood insurance zones, and base flood elevations for the flooding source studied in detail in the community.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the City of Selah is, for insurance purposes, the principal result of the Flood Insurance Study. This map (published separately) contains the official delineation of

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FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FHF	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10 YR.)	2% (50 YR.)	0.2% (500 YR.)			
Yakima River Reach 1	02	-3.81	-1.44	+3.27	040	A8	Varies

[1]FLOOD INSURANCE RATE MAP PANEL
[2]WEIGHTED AVERAGE
[3]ROUNDED TO THE NEAREST FOOT–SEE MAP

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SELAH, WA
(YAKIMA CO.)

FLOOD INSURANCE ZONE DATA

YAKIMA RIVER

flood insurance zones and base flood elevation lines. Base flood elevation lines show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. This map is developed in accordance with the latest flood insurance map preparation guidelines published by the FEMA.

6.0 OTHER STUDIES

The Seattle District COE conducted a study, the findings of which were contained in the Flood Plain Information Report for the City of Selah and vicinity, published in June 1973 (Reference 4). The report included high water profiles and flood-area maps for the Intermediate Regional Flood (100-year recurrence interval) and the Standard Project Flood. In the course of subsequent studies of flooding in the Yakima River Basin, the COE had occasion to re-evaluate the hydrological basis for the estimates of peak flood discharges (Reference 9). These revised discharges were incorporated into the previously developed computer models of the Yakima River in the vicinity of Selah. New profiles were calculated; however, a report containing the updated results has not been published. The results were made available to the study contractor for this Flood Insurance Study and the presentation contained herein is consistent with the COE's most recent findings.

This study is authoritative for the purposes of the Flood Insurance Program and the data presented here either supersede or are compatible with previous determinations.

7.0 LOCATION OF DATA

Survey, hydrologic, hydraulic, and other pertinent data used in this study can be obtained by contacting the office of the Federal Insurance Administration, Regional Director, Region X, 130 228th Street, S. W., Federal Regional Center, Bothell, Washington 98011.

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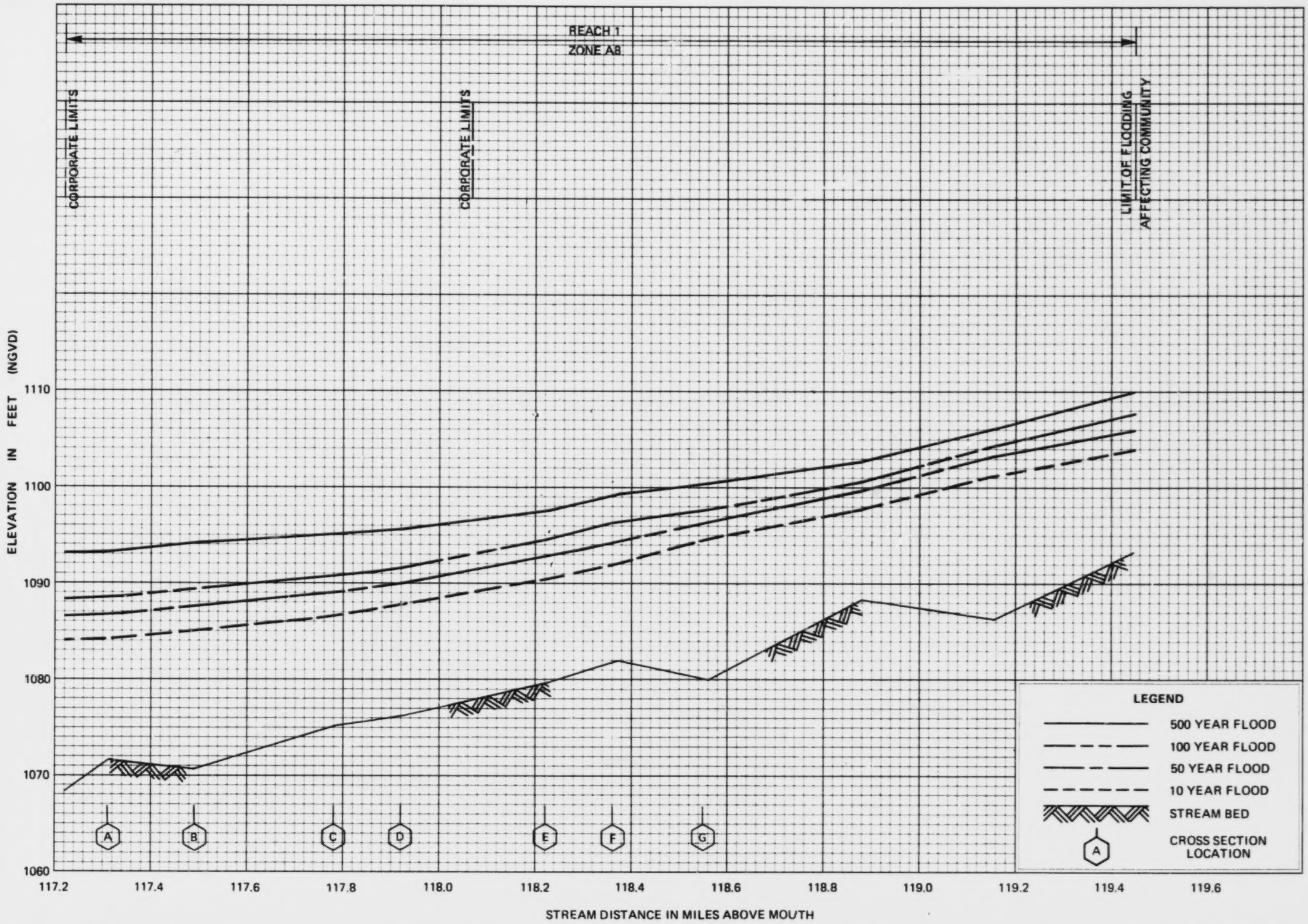

FLOOD PROFILES

YAKIMA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SELAH, WA
(YAKIMA CO.)

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